Research Article

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Glycemic Control and its Determinants among Ambulatory Patients with Type 2 Diabetes

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Abstract

Background: Diabetes Mellitus has become one of the most important public health challenges of the 21st century. The rate of increase in the incidence will be dramatically higher in developing countries and is paralleled by a skyrocketing increase in its chronic complications responsible for the huge premature morbidity and mortality associated with the disease. The development of long-term complications is influenced by hyperglycemia and poor control of diabetes could accelerate their progression.

Methods: A cross sectional study was conducted to determine the adequacy of glycemic control and identify factors associated with poor glycemic control. Three hundred twenty two ambulatory patients with Type 2 diabetes mellitus were involved in the study. It was a two phase study where data collection was carried out between May 01 and June 30, 2014. The most recent fasting blood sugar level was used for assessing glycemic control.

Results: Only 12.7% of patients attained adequate glycemic control. Male sex, younger age, low educational status, regular alcohol intake, exercise and dietary non-adherence were observed to be significantly associated with poor glycemic control. Study findings showed that glycemic control was poor, which requires health care professionals to seriously address the issue in order to achieve a better diabetes care.

Keywords: Type 2 Diabetes, Glycemic control, Fasting blood sugar (FBS), Morisky

Introduction

Diabetes Mellitus (DM) is an endocrine disorder of various etiologies manifested by long term hyperglycemia, which causes significant physical and psychological morbidity, disability and premature mortality among those affected patients and imposes a heavy financial burden on health services [1,2]. Generally, 40% of patients with diabetes will develop microvascular or macrovascular complications in the course of their disease [3]. The vast majority of cases of diabetes fall into two broad categories: type 1 and 2 diabetes [2,4]. The prevalence of Type-2 diabetes is alarmingly growing around the globe with 80% of the affected individuals residing in low and middle income countries, including Ethiopia. More than 4% of Ethiopians are estimated to live with diabetes mellitus in the year 2013. [5].

DM has become one of the most important public health challenges of the 21st century. The rate of increase in the incidence will be dramatically higher in developing countries and is paralleled by a skyrocketing increase in its chronic complications responsible for the huge premature morbidity and mortality associated with the disease [6]. The development of long-term complications is influenced by hyperglycemia and poor control of diabetes could accelerate their progression [7]. One of the primary goals of diabetes management therefore is to lower blood glucose levels because it is well established that improved glycemic control delays the onset and retards the progression of these complications of microvascular and macrovascular type [8]. As such, regular testing of blood glucose is a cornerstone and achievement of adequate glycemic control is a goal for proper diabetes car [4]. It is recognized that there are limited research works doneinn the area in Ethiopia, therefore the present study was conducted to assess the level of glycemic control and factors associated with poor glycemic control among ambulatory type 2 diabetic patients. The findings are believed to be utilized in the betterment of diabetes care service in Ethiopia and other areas in general.

Materials and Methods

A cross sectional study was conducted in two-phases: patient interview and chart review. Patient interviews and medical record reviews were conducted from 1st of May to 30th of June, 2014. The sample size calculated using single population proportion formula was 385. As the actual number of source population in the study period was 120, the corrected sample size, using a correction formula was 292; a 10% contingency yielded a final sample size of 322. Systematic random sampling method was used to recruit samples for the study. All patients with type 2 diabetes and on treatment with anti-diabetic drugs at least for 3 months, who were ≥ 18 years of age and who understood the local language were included in the study. A questionnaire was utilized to gather information about patients' socio-demographic characteristics, duration of diabetes, knowledge about diabetic complications, medication adherence and self-management practices of diabetic care. Information on fasting blood sugar, co-morbidities, diabetic complications, and prescribed medications was obtained from reviewing individual patient medical records.

The data collection instruments were assessed by a physician and expert in the field of endocrinology for clarity and comprehensiveness of contents. Pre-testing of the instruments was also done among 5% of randomly selected, type 2 diabetes patients, who were not included in the study, ahead of the start of the main data collection. Good/ Adequate glycemic control was regarded as Fasting Blood Sugar (FBS) ≤ 110 mg/dL [8,9]. The collected data was entered into Epi Info v-3.5.3 and analyzed using SPSS v-21. Descriptive statistics including: frequency, mean and standard deviation were used to summarize patients' baseline socio-demographic data and evaluate the distribution of responses. Crude and Adjusted Odds Ratio (COR/ AOR) were calculated and 95% confidence level was used to determine factors associated with poor glycemic control. A p-value of 0.05 or less was considered statistically significant. Ethical clearance and approval of the study protocols was granted. Prior to data collection, individual informed verbal consent was obtained from the study patients.

Results

Socio-demographic characteristics

Females comprised 59.3% of the sex category. Majority of the patients were in the age group of 51-60 years, which accounted for 30.7%. The mean age of the studied population was 52.68 (SD=11.17) years (range 18 to 82 years). Being a Housewife (98, 30.4%) accounted for the highest percentage of occupation. Patients with higher education (94, 29.2%) constituted the highest percentage of educational status category (Table 1).

Variables		Frequency	Percent (%)
Sex	Male	131	40.7
	Female	191	59.3
Age (Years)	≤ 40	51	15.8
	41-50	93	28.9
	51-60	99	30.7
	61-70	58	18
	>70	21	6.5
Marital Status	Single	42	13
	Married	194	60.2
	Divorced	39	12.1
	Widowed	47	14.6
Occupation	House Wife	98	30.4
	Government Employee	62	19.3
	Retired	54	16.8
	Merchant/Trade	48	14.9
	Unemployed	19	5.9
	Farmer	10	3.1
	Daily Laborer	7	2.2
	Others	24	7.5
Educational Status	Cannot Read and Write	70	21.7
	Primary	91	28.3
	Secondary	67	20.8
	Higher Education	94	29.2
*Carpenter, Construction, Driver, Garage (mechanic), Guard, Metal Work, Teacher working in private school			

Table 1: Socio-demographic characteristic of patients with type 2 diabetes.

Self-management practices of diabetes care

The self-management practices of diabetes care for the studied patients included: diet restriction (207, 64.3%), exercise (69, 21.4%), self-monitoring of blood glucose (SMBG) (11, 7.4%), never drink alcohol regularly (235, 71.0%) and never smoke (285, 88.5%). None of the patients had dietary plans prepared with their physicians, but majority of them were simply told to cut off sweet carbohydrate and fatty meals (Table 2).

Variables			Frequency	Percent
DIET	Dietary Approach	Cut off Sweet Carbohydrate Meals	276	85.7
		Cut off Fatty Meals	216	67.1
	Overall Dietary Adherence	No	115	35.7
		Yes	207	64.3
EXERCISE	Presence of agreed Exercise plan with physicians	No	253	78.6
		Yes	69	21.4
	Exercising According to Plan (n=69)	No	42	60.9
		Yes	27	39.1
	Days per Week Doing Moderate Intense Exercise	<3 Days	101	31.4
		≥ 3 Days	220	68.6
	Duration of Moderate Intense Exercise per Week in Minutes	<150 Minutes	260	80.7
		≥ 150 Minutes	62	19.3
	Overall Exercise Adherence	No	260	80.7
		Yes	62	19.3
ALCOHOL	Ever Drink Regularly	No	235	71
		Yes	87	27
	Drinking Regularly Now (n=87)	No	85	97.7
		Yes	2	2.3
	How much Drink Servings Per Day(n=2)	≤ 2 for Males and ≤ 1 for Females	1*	50
		>2 for Males and >1 for Females	1*	50
CIGARETTE	Ever Smoked	No	285	88.5
		Yes	37	11.5
	Smoking Now (n=37)	No	28	75.7
		Yes	9	24.3
	Amount of Cigarettes Per Day in Packs (n=9)	<Half a Pack	7	77.8
		Half a Pack	2	22.2
SELF-MONITORING OF BLOOD GLUCOSE (SMBG)	Presence of Glucometer	No	174	54
		Yes	148	46
	Number of Blood Glucose Measurements Per Week (n=148)	<1 Time Per day	137	92.6
		≥ 1 Time Per day	11	7.4
*Male Sex				

Table 2: Self-management practices of diabetic care among type 2 diabetic patients.

Antidiabetic medication adherence

Assessment of patients' responses to a 4-item Morisky adherence predictor scale showed that 215 (66.8%) patients were adherent to the prescribed regimen of their antidiabetic medications.

Glycemic control using fasting blood sugar

The most recent FBS value was regarded as the measure of glycemic control in this study, while the other values collected were used to see the trend of glycemic control among the study population. Accordingly, only 41 (12.7%) patients attained adequate glycemic control. The mean glycemic level was 192.7 (SD=76.5) mg/dl, with a range value of 52.0 to 444.0 mg/dl (Table 3).

FBS Values	Frequency (%)		Mean (SD) mg/dl	Min (Max)mg/dl
	≤ 110 mg/dl (Adequate)	> 110 mg/dl (Inadequate)		
Most Recent Value (n=322)	41 (12.7)	281 (87.3)	192.7 (76.5)	52.0 (444.0)
Last appointment (n=312)	55 (17.5)	259 (82.5)	180.4 (74.8)	48.0 (427.0)
Second last appointment (n=310)	55 (17.6)	257 (82.4)	193.2 (88.3)	47.0 (490.0)
First appointment (n=318)	7 (2.2)	311 (97.8)	268.8 (103.6)	81.0 (650.0)
Most Recent SMBG (n=109)	19 (17.4)	91 (82.6)	178.5 (69.5)	45.0 (400.0)

Table 3: Fasting blood sugar measurements of type 2 diabetic patients.

Treatment adherence and glycemic control

Among 215 (66.8%) patients who reported adherent to their antidiabetic medications, 29 (13.5%) of them attained adequate glycemic control. However, among the 29 (9%) patients who adhered to all treatment recommendations (antidiabetic medications, dietary & exercise recommendations), 7 (24.1%) of them attained adequate glycemic control (Table 4).

	Adequacy of glycemic control		
	Poor/Inadequate	Good/Adequate	Total
Antidiabetic Medication adherent	186 (86.5%)	29 (13.5%)	215 (100%)
Overall treatment adherent	22 (75.9%)	7 (24.1%)	29 (100%)

Table 4: Treatment adherence and glycemic control among type 2 diabetic patients.

Factors associated with glycemic control

The present study revealed that sex, age, educational status, dietary adherence, exercise adherence and ever drinking alcohol were found to be significantly associated with glycemic control during a multivariate logistic regression analysis (Table 5).

Discussion

The glycemic control in the present study was only adequate for 12.7% of the study population, which made the glycemic control to be very poor and inadequate. This result was lower than the results from various studies, which reported a rate ranging from 17% to 62% [10-15]. The management of DM ensures normal FBS levels necessary for short-term and long-term control and reduction of acute and chronic complications. Glycemic control is a strong predictor of diabetes complications, particularly microvascular complications. Failure in achievement of clinical blood glucose targets is therefore of phenomenal importance and can lead to increased hospital visits, preventable emergency admissions and deaths. In the present study, female patients were found to have adequate glycemic control compared with male counterparts.

This finding was in agreement with Nigerian and Indian studies which reported male sex as a risk factor for poor glycemic control [10,12]. On the other hand, educational status was shown to have a positive association with glycemic control. As patients' educational status gets increased, the likelihood of attaining adequate control was also increased. Some studies also revealed similar findings which stated that low educational status is associated with inadequate glycemic control [16-19]. Education is undoubtedly essential for the achievement of the high standards of self-management on which good diabetic control depends.

Variables	Glycemic Control		COR , 95% CI	AOR, 95% CI
	No (%)	Yes (%)		
Sex				
Male	121(92.4)	10(7.6)	1	1
Female	160(83.8)	31(16.2)	2.34(1.11, 4.97)*	3.47(1.22, 9.91)*
Age Category				
≤ 40	46(90.2)	5(9.8)	1	1
41-50	87(93.5)	6(6.5)	1.51(0.38, 5.95)	2.82(0.62, 12.74)
51-60	86(86.9)	13(13.1)	2.42(0.66, 8.91)	3.22(0.76, 13.70)
61-70	46(79.3)	12(20.7)	4.17(1.11, 15.75)*	8.32(1.76, 39.35)*
≥ 71	16(76.2)	5(23.8)	5.00(1.07, 23.30)*	31.30(4.07, 240.90)*
Educational Status				
Cannot Read and Write	65(92.9)	5(7.1)	1	1
Primary	77(84.6)	14(15.4)	4.76(1.33, 17.07)*	13.66(2.94, 63.55)*
Secondary	57(85.1)	10(14.9)	3.92(1.03, 14.93)*	20.09(3.80, 106.14)*
Higher Education	82(87.2)	12(12.8)	3.27(0.89, 12.06)	20.72(3.78, 113.51)*
Ever Drink Alcohol Regularly				
No	201(85.5)	34(14.5)	1	1
Yes	80(92.0)	7(8.0)	0.19(0.06, 0.62)*	0.15(0.03, 0.65)*
Total Number of Drugs				
1	23(79.3)	6(20.7)	1	1
2	74(92.5)	6(7.5)	1.10(0.28, 4.37)	1.30(0.26, 6.54)
3	48(90.6)	5(9.4)	0.90(0.20, 4.008)	1.26(0.22, 7.33)
4	64(87.7)	9(12.3)	1.22(0.31, 4.86)	1.56(0.29, 8.32)
5	35(77.8)	10(22.2)	2.48(0.62, 9.91)	3.16(0.59, 16.96)
>5	37(88.1)	5(11.9)	1.17(0.26, 5.34)	1.18(0.19, 7.14)
Antidiabetic Medication Adherence				
No	95 (88.8)	12 (11.2)	1	
Yes	186 (86.5)	29 (13.5)	1.23 (0.60, 2.53)	
Dietary Adherence				
No	106(92.2)	9(7.8)	1	1
Yes	175(84.5)	32(15.5)	2.15(0.99, 4.69)	3.27(1.23, 8.67)*
Exercise Adherence				
No	233(89.6)	27(10.4)	1	1
Yes	48(77.4)	14(22.6)	2.52(1.23, 5.15)*	3.37(1.39, 8.20)*
*Statistically Significant: P ≤ 0.05				

Table 5: Multivariate logistic regression analysis result of factors associated with glycemic control among type 2 diabetic patients.

Regarding age, older patients were found to have higher odds of attaining adequate control than younger patients. The finding that younger age was associated with worse glycemic control is congruent with similar [18,20-24]. It is not fully understood why younger patients have worse glycemic control than older patients. These patients have a higher lifetime risk of developing micro- and macro-vascular complications. They might be more likely to disregard diabetes as being important and could be less adherent to medications, lifestyle and diet restrictions. On the contrary, older patients might be more motivated to take care of their diabetes and be more compliant with their medication, regular physical activity and eat healthy low-fat diet.

In the present study, patients who were adherent for both exercise and dietary recommendations were more likely to adequately control their blood glucose levels, compared to their respective counterparts. Similar studies also reported consistent findings with respect to these variables [17,21,25-29]. In the present study, however, in spite of the significant association, only 64.3% and 21.4% of the patients were found to be adherent to diet and exercise recommendations, respectively. Attaining adequate glycemic control is not solely dependent on adherence to medications; rather it needs a multimodal approach including adherence to dietary and exercise recommendations. Despite the benefits in type 2 diabetes, research has noted that healthcare professionals inadequately address this issue, resulting in physical activity being an underutilized therapy. Thus, it is a matter of necessity to educate patients with type 2 diabetes at their every visit to their physician about the importance of these lifestyle modifications.

In this study, patients who ever drunk alcohol regularly were found to have lesser odds of controlling their glycemic level compared to those who never drunk regularly. Various studies showed that alcohol consumption is inversely associated with glycemic control among diabetes patients [30,31]. The greatest impact of alcohol is seen in those who drink heavily on a frequent basis. Along with the impact on blood sugar, studies have also shown that alcohol can impact the effectiveness of the hypoglycemic medications, so extreme caution needs to be taken when consuming alcohol by anyone with diabetes. Given the tremendous disease burden and financial costs associated with diabetes complications, understanding modifiable predictors of diabetes disease course has great public health significance. Alcohol consumption is a very common, potentially modifiable behavior that may impact diabetes disease course. Being a retrospective study and use of FBS as a measure of glycemic control were the main limitations of the study; hence caution has to be exercised in interpreting the findings of the study taking into consideration of these limitations.

Conclusions

Despite the use of multiple antidiabetic medications (both oral and insulin), only 12.7% of patients attained adequate glycemic control, which indicated that there was poor glycemic control among the study population. Younger age, male sex, low educational status, drinking alcohol regularly and each of exercise and dietary non-adherence were factors that had a significant association with poor glycemic control. A relatively higher antidiabetic medication adherence rate did not appear to have an appreciable effect on patients' fasting blood glucose values, as a sizeable number of patients had an FBS above the recommended glycemic goals indicative of adequate control. In view of the adverse effects of hyperglycemia leading to severe morbidity and increased mortality among the diabetic patients, a tight control of blood glucose level is mandatory. As a sizeable number of patients had poor control relative to the number of patients who adhered to antidiabetic medications, the efforts of health professionals engaged in diabetic care also should gear towards ensuring patient's adherence to other aspects of diabetes management plan, including diet and exercise adherence, so as to optimize outcome. Larger studies are required to look the association between antidiabetic medication adherence and glycemic control in the study area.

Acknowledgement

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